UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

CIRCULAR No. 263

MAY, 1923

TOMATO PRODUCTION IN CALIFORNIA

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The production of tomatoes is one of the important agricultural industries of California. In 1922, 2,226 carloads of tomatoes were shipped for table purposes; the canneries packed 1,925,389 cases of the whole tomato, and 1,498,617 cases of other tomato products, such as pulp, puree, catsup, and paste. Large quantities are grown for local markets; a considerable acreage is grown especially for seed production; and in home gardens throughout the state the tomato is a crop of first importance. Thus it is seen that the tomato is grown for a number of distinct purposes in the state, each amounting to a business of considerable proportions. While each of these lines of production and utilization have grown steadily in recent years, there is at the present time some concern over the relatively low yield per acre. The average yield for California has varied from 5.5 to 7.2 tons an acre in recent years. While these yields are much above the average for the whole United States, they are far below the possibilities of economic production with the favorable soil and climatic conditions existing in many sections of the state. Yields of ten to twenty-five tons per acre are frequently obtained and such yields are attainable easily by skillful growers. Surveys in other states have shown that the grower producing yields below the average is likely to be losing money on the crop, while other growers in the same district whose yields are above the average, make a good profit. The object of this circular is to describe successful methods of growing and handling the crop, and to point out in a general way some of the basic principles underlying better production. However, when the culture of such a crop as tomatoes is considered, due allowance must always be made for the diversity in soil and climatic conditions existing within the state, and the variety of purposes for which the crop is grown.

PRODUCING REGIONS

At present commercial production is more or less centered in a number of important districts. The earliest tomatoes are grown in the Imperial Valley and are shipped in considerable quantities to Western markets. Possibly the use of a better shipping variety, or the adoption of better cultural practices, may result in the production of fruit that can be marketed successfully further east in competition with the Florida crop.

Los Angeles, Ventura, Riverside, Orange and San Diego counties produce a large quantity of tomatoes for all of the uses to which the crop is put, but most important part of the tomato business in this district is the production of a late or fall crop for eastern shipment. From September to December, after disease has killed the plants in the southern states and frost has ended the crop in the northern states, there is a good demand for California tomatoes in the East.

The San Joaquin Valley has considerable tomato production, most important being the production of early tomatoes for shipment, centered at Merced. After the shipping season ends, the later part of the crop is utilized for manufacturing purposes. Tomato production in this section is on an extremely intensive basis and the returns by the acre are high.

The Santa Clara Valley is one of the oldest and most important districts for the production of tomatoes for canning and manufacturing.

The San Francisco Bay district is an important producer of canning and manufacturing stock, as well as fruit for local markets and for shipment to the East during the fall months. Some growers contract their entire crop to a cannery, while others ship their crop when market conditions provide a profitable outlet, but when the market demand is not good, turn their crop or a portion of it to the canneries.

The Sacramento Valley has several districts which are producing canning tomatoes extensively. One of the most important districts is around Sacramento.

Sonoma County is one of the most important districts for cannery production.

There are many other localities where the crop is grown for canning and other purposes on a smaller scale. Production for local markets is more or less important in all parts of the state. Fifty-two counties in California report a commercial tomato acreage. The most important counties in point of production are listed in the following table with the number of acres for 1919.

CALIFORNIA TOMATO ACREAGE BY COUNTIES

	ACRES		ACRES
Alameda	3,609	San Bernardino	710
Contra Costa	834	San Diego	609
Imperial	270	San Joaquin	1,480
Kern	144	San Mateo	308
Los Angeles	8,021	Santa Clara	5,679
Monterey	105	Solano	529
Orange	1,331	Sonoma	1,708
Riverside	1,109	Stanislaus	986
Sacramento	1,005	Ventura	128
San Benito	819	Yolo	1,439

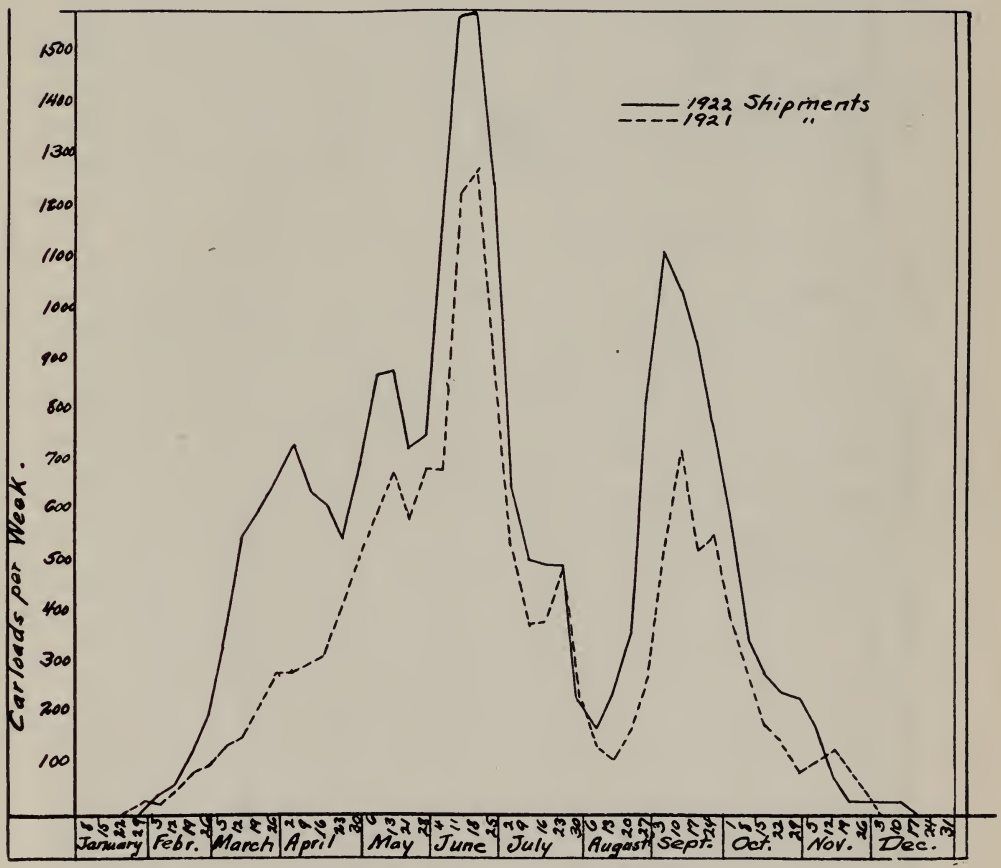

Fig. 1.—Showing the total carload shipments of tomatoes for the United States by weeks in 1921 and 1922.

SHIPMENT SEASONS

To make clearer the opportunities for tomato production for shipment to outside markets, and to show the relation of tomato shipments from California to those from other sections and from the United States as a whole, two shipment charts have been prepared.

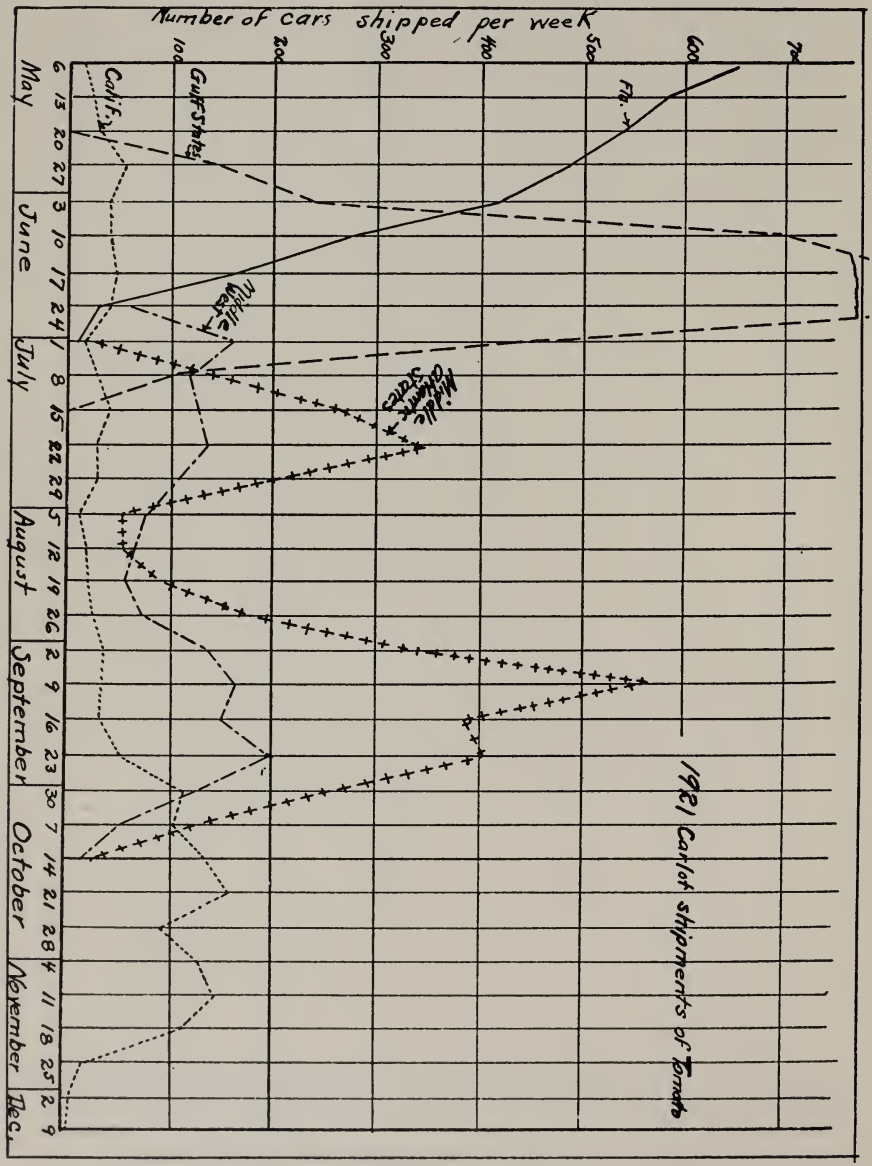

Fig. 2.—Showing the volume and season of shipment of tomatoes from the principal districts.

A glance at figure 1 shows that tomatoes are shipped almost throughout the year. Shipments gradually increase during the early spring until a peak is reached in June. Thereafter, shipments decrease and the total number of cars shipped during July and August is relatively low. This is the period of local production in the North and East, so that carload shipments from outside districts are not needed. Late in August, shipments begin to increase considerably, and the market on tomatoes improves at this season due to exhaustion of home-grown supplies in the East. This leads to a second peak of shipments during the fall, which declines rapidly as frost cuts down one shipping section after another. By the middle of December the only shipments of any importance are those from Mexico. It is noted in figure 2 that shipments of early tomatoes in California are not very important, due to heavy production in other sections nearer the big markets of the country. However, after the first week of October, California is the only important shipper of tomatoes. For a period of two months in the fall, California tomatoes have command of the markets of the entire country. Production for shipment in this period seems especially promising.

LOCATIONS FOR TOMATO PRODUCTION

Before engaging in extensive tomato production, the grower must make sure that there is a profitable outlet for his crop, that is, he must have access to a good local market, to a cannery or other manufacturing plant, or be so situated that he can ship to advantage. It is not advisable to grow the crop for shipment unless the acreage is large enough to make carload lots possible, either by the individual grower or by groups or associations of smaller growers located in the same community. There are several such associations doing a successful business in the state, and there should be more of them. The season at which the crop will mature and the probable market conditions existing at that season should also be considered.

Cultural conditions must also receive attention. The tomato is a heat-loving plant and the long growing season in most parts of the state is very favorable for tomato production. Localities subject to late spring or early fall frosts, or with very cool summer climate are not suitable for the crop. As to soil, the tomato is not particular, though this factor influences yield, quality and time of maturity to some extent. Muck soils produce a very poor quality of fruit, sandy soils favor an early maturing crop, while heavier soils are especially suited for late maturing or fall crops. Good drainage is always

essential. Soils that are too moist for any considerable period during the growing season usually produce a poor crop. Tomatoes in some sections are grown on sub-irrigated land. If the water-table comes too near the surface, excessive vine growth and a poor set of fruit will result. Soils that are excessively rich in nitrogenous matter may produce the same bad result.

CROPPING SYSTEMS

At present a large portion of the tomato crop in northern and central California is produced in connection with a winter crop of spinach. The tomato vines are pulled and burned at the end of the season in November, the land is fitted and sown to spinach at once. The spinach crop is harvested in March and April, and the land fitted in time to plant tomatoes again. This combination is a good one, but will lead to bad results if the same land is continuously cropped in this way, in fact, it seems that this practice is partly responsible in some cases for recent low yields of tomatoes. Tomatoes should not be grown more than once in four years on the same piece of land; they should be grown in rotation with other crops. Various diseases often become very common and do much damage when tomatoes are grown continuously.

Tomatoes are extensively grown as an intercrop in young orchards, to which purpose they are well adapted when the irrigation practice for tomatoes does not conflict with the requirements of the trees. This may sometimes be an objection, especially in young walnut groves.

PLANT PRODUCTION

For the sake of economy of seed, earliness and convenience in growing the crop, the plants are usually grown in beds of one kind or another, from which the plants are transplanted to the field at the proper time. The best method of growing the plants varies according to the locality and the season at which the crop is desired.

The Hotbed-Coldframe Method.—The hotbed-coldframe method is generally best for early market crops, and perhaps should be used even for the late shipping and canning crop in central and northern California. This method is described in detail herein, because its more extensive use seems desirable. The hotbed frame should be located in a warm, sunny, well drained spot. About one foot of fresh hot horse manure is placed in the bed, tramped down, and a layer of soil four

inches deep placed over this. It is best to use a sandy soil or a mixture of one-half sand and one-half garden soil in the hotbed. This gives stronger plants with good root systems. The seeds are planted about ten weeks before time of field setting, sowing them broadcast, or drilled into rows about four inches apart and covered about one-half inch deep. If good seed are sowed at the rate of twelve or fifteen seeds per inch of row, one hotbed six by twenty-four feet in size should produce about 50,000 seedlings. The hotbed should be kept warm and moist until the plants are up, after which time it should be well ventilated and watered sparingly. As soon as the seedlings show their first rough leaves, they are ready to transplant to the coldframe. This is a tedious task but one that is worth doing well and carefully. The coldframes are prepared much like the hotbeds except that no manure is placed under them. A suitable covering for the frames may be made of eight or ten-ounce muslin. About four inches of fine soil should be placed in the coldframe, preferably a mixture of one part garden soil, one part sand, and one part rotted manure, all well mixed and screened through a screen of one-half-inch mesh if possible. The seedling plants from the hotbed are set therein about two by two inches apart usually, though wider spacing will give better results. Watering should follow transplanting and the frames should be kept covered a few days, until the plants have taken root. This is especially necessary if the sun is warm or the weather windy. After the plants have begun to grow, the frames should be ventilated freely during the day time, and watered only enough to keep the plants growing fairly fast. When the plants are ten inches high, the beds should be gone over and the terminal bud pinched out of each plant. This prevents the plants from growing any taller, and encourages the development of thick stout stems and good root systems. At the same time, shoots begin to develop in the axils of the leaves. In this manner, the framework for a large bushy plant is started before the plants are set in the field. This treatment of "topping" the plants two or three weeks before transplanting to the field has been found, in experiments by the writer, to result in considerable increases in yield of fruit. It has also been successfully practiced for years by certain growers in the Sacramento district, and perhaps elsewhere.

For a week or ten days before transplanting the plants to the field, the beds should be left open day and night, and only enough water applied to keep the plants from very serious wilting. This treatment toughens or "hardens" the plants so that they will stand transplanting without damage or severe shock, which so often kills tender plants when set in the open field.

The Coldframe Method.—This method is frequently used where plants have to be started during cool weather but not so early as to require the hotbed method. Frames are prepared running east and west in a sheltered sunny spot. A four-inch layer of sandy, fertile soil should be placed in the frame. The seed are sowed by hand or with a seed drill, being planted thinly in rows four to six inches apart. After germination, the beds should be weeded and the plants thinned to about three plants per inch. This method can be used to produce large numbers of plants cheaply, but good large stocky plants with well-developed roots are seldom grown in this way, the seed being usually planted too thick and the growers failing to do the necessary thinning.

The Open Bed Method.—This is probably the cheapest way to grow plants but it is not adapted for sections having short growing seasons or for early crop production. It is adapted for growing plants for the late shipping crop in southern California and for the canning crop in northern California, though in the latter case it is believed that the hotbed method is really better. For the open bed method, beds are prepared in a well drained sheltered spot, preferably where the soil is sandy. The seed are drilled in with a seeder as soon as the soil warms up and danger of frost is over (about March 15 in the Sacramento district). Narrow beds thirty to thirty-six inches from center to center are thrown up with a lister, the ridges are harrowed down and levelled with a planker, and a double row is sowed on each bed. The furrow between the beds is used for irrigation when necessary. It is very important to see that the seed are not planted too thickly even in these open beds, and thinning the plants in the thicker portions of the bed should be practiced.

Care of Plant Beds.—Plant beds must be weeded and cultivated to prevent crust formation around the plants. Thinning the plants is often necessary, for if crowded they develop weak spindling stems resulting in plants of very poor quality. Particular care should be given to the watering of plant beds, for over-watering results in weak, sappy, leggy plants that are hard to transplant to the field and which recover slowly if they survive transplanting. Excessive moisture, especially if given late in the day, encourages "damping off," a disease which sometimes wipes out many plants overnight. Waterings should be given usually several days apart, and not until the plants show need for it. No harm is done if the plants are checked by lack of water. Tomatoes, unlike most other vegetable plants, suffer little permanent injury even if severely checked in the seed-

ling stage. However, holding plants for a long period after they have reached transplanting size will lead to bad results.

The day before transplanting to the field, the beds should be soaked well so that the plants can be easily removed. In taking up the plants, it is better to dig them with a spade, rather than to pull out by hand, which is the too general practice.

Seeding directly in the field.—In sections having a long season, tomatoes may and sometimes are, planted directly in the field when the soil has become warm. This method is wasteful of seed, involves considerable labor in thinning, and is seldom practiced when tomatoes follow a spring crop of spinach. Only varieties that mature in a medium or short season should be grown this way.

FIELD CULTURE

Except where following spinach or other winter crop, tomato land should be fall-plowed as deeply as possible. In spring, before the surface gets hard and dry, the land should be disced to kill weeds and get the soil into fine condition. The method of preparing for the plants and method of transplanting depends upon the locality and the soil conditions. In most sections, when setting for the early crop, it is easy to set the plants without watering if the soil is handled properly. Under such conditions, the field is prepared level and marked off in both directions and the plants set at the intersections if they are set by hand. In setting large acreages, however, much time and labor can be saved by the use of a horse-drawn transplanter. These machines, of which there are several types on the market, set the plants as well as they are usually set by hand, and can be used to water the plants if watering is necessary.

In dry sections and in most sections during dry seasons, it is necessary to water the plants as they are transplanted. This is almost always necessary in setting the late crop. If irrigation water is available, the simplest plan is to mark the rows with a plow. The plants are set the proper distance apart on the edge of the furrow and a small stream of irrigation water is turned into each row as it is set. Cultivation must follow within a day or two, to prevent a hard crust forming around the roots. At this time the soil should be worked toward the plants, thus beginning the bed which should be gradually formed for each row.

Another way to set plants under dry conditions is to haul a number of barrels of water into the field, placing the barrels across the field at convenient intervals. As the plants are set, a little water is poured about the roots from a can.

In transplanting tomatoes, the plants should be set as deeply as possible, usually four or five inches deeper than the plants were in the plant bed. New roots develop along the stem giving the plant a much larger and deeper root system than can be obtained when the plants are small and set shallow. Deep setting is of course more laborious than the customary shallow setting, but it encourages the plants to develop large, deep root systems, which enables plants to make use of the moisture in the lower soil. Deeper plowing than usual for tomatoes aids in securing the same result. Plants with deep roots are most assured of an even moisture supply, do not require so frequent irrigations, and do not suffer from the sharp fluctuations of alternately having too much and not enough water. It seems that many of the troubles affecting tomato plants in California are connected with their shallow root systems.

Fig. 3.—A tomato field furrowed for irrigation.

Irrigation.—In some parts of the state, satisfactory tomato crops can be grown with little or no irrigation, if the plants are given a chance to develop deep root systems. However, in most sections some irrigation is necessary, the number and frequency of irrigations being determined mostly by local conditions. Enough water should be applied to keep the plants growing steadily. Over-irrigation favors excessive vine growth and sometimes causes the blossoms to drop without setting fruit. The best method is to open a furrow alongside each row of plants so that the moisture can seep down to the roots without wetting or compacting the surface soil (fig. 3). Cultivation should follow promptly, throwing the soil toward the plants. For each successive irrigation, the furrow is made further from the plants and by mid-season a broad low bed has been formed, which is covered by the sprawling plants. Between the beds is the dead-furrow which may be used for later irrigations, allowing the water to seep down to the roots without wetting the surface on which vines and fruit are resting.

There are two periods at which water should not be applied—during the period when the first blossoms are open, and during the latter part of the fruit-ripening period. Irrigation at the earlier period will decrease the set of fruit, and at the later period will retard the maturing of the crop. However, in some sections where a late crop is grown for fall shipment, the practice is to irrigate just as the first cluster begins to bloom. This prevents the setting of early fruit and may encourage the development of a larger plant that will produce more late fruit.

Planting distances.—The planting distance is determined by the variety, the soil, and the season at which the crop is grown. Early tomatoes grown under intensive culture, where the plants are staked and trained to a single stem, as in the Merced district, are set 15 inches by 3 feet apart, this requiring about 12,000 plants per acre. Early varieties where not staked and pruned, are usually set about three by four feet, requiring about 3,600 plants per acre. The late shipping and canning crop, the varieties used for which generally make very vigorous vine growth, are set from 6 by 6 feet to 8 by 8 feet apart, depending on the locality and soil fertility. This crop then requires from 700 to 1,200 plants per acre.

The wider spacings are more economical of plants and labor than the closer plantings. Yet there is no reliable data available to indicate whether wide or close planting pays best. Certainly the rows must be wide enough to allow cultivation and irrigation and to permit easy passage for the pickers without trampling upon the plants.

HARVESTING

The exact stage of maturity at which the fruit is picked depends upon the purpose for which it is to be used.

For sale on local markets, for canning and for pulp manufacture, the fruit should be well colored when picked.

For shipment to nearby points the fruit is harvested in the "pink" stage, when about half of the surface shows distinct color.

For shipment to distant markets, the fruit is picked usually in the "green-mature" stage—when fully grown but not yet beginning to show color. Fruit at this stage should, however, appear whitish at the blossom end. Mature green fruits if cut open are found to have the cells well filled with the gelatinous pulp in which the seeds are embedded. Fruits picked in the green-mature stage ripen and color up perfectly in from one to three weeks, depending upon the temperature. The quality of such fruit is good when

ripened in air, but when wrapped in tissue paper, as is the usual commercial practice, the flavor and texture of the artificially ripened fruit is not so good. Another defect in the practice of picking and shipping green-mature fruit is that careless pickers gather many fruits that are not mature. Such fruits are worse than a dead loss to the grower, for they never attain good edible quality when artificially ripened.

For shipping tomatoes, the fields are generally gone over once a week, and fruit in all of the above stages of ripeness gathered at once. The ripe fruits, however, are placed in separate containers by the picker, and are disposed of on the local market or to the canner. The pink, turning, and green fruit is hauled to the packing shed, where it is sorted, graded, wrapped and packed for shipment. This part of handling the crop can generally be taken care of through a local coöperative packing and shipping association, or by a reputable distributing organization, better than by the individual grower.

Great care should always be taken in handling tomatoes for any or all purposes, to avoid bruising or breaking the skin. The tomato fruit is a highly perishable article at best. Pickers should always remove the stems from the fruits as they are picked, to prevent puncturing the skins of other fruits.

Persons interested in the packing and shipping of tomatoes should secure Farmers' Bulletin 1291 from the United States Department of Agriculture, Washington, D.C.

VARIETIES

Selection of a variety adapted to the purpose and the location where it is to be grown is the first step in the production of a good crop. Unfortunately some lots of seed, while approximately true to name, produce fruit of poor type. It is high time that all growers of tomatoes should begin to pay close attention to the variety used, and to the source and quality of the seed. The cost of the seed is an insignificant item because of the small amounts used. One pound is sufficient for twenty-five acres in most of the ordinary methods of planting in California. The following varieties are now used extensively for the various purposes, or have shown promise for use in the state.

Earliana.—This is the earliest maturing variety. It is characterized by small, weak vines and bears medium to small red fruits that tend to be quite flat and rough, which are serious defects. Some strains are claimed to be of better type and more productive than

the general run of this variety. It should be used only on a limited scale for extra early crop, if at all.

Bonny Best.—This variety is a week or ten days later than Earliana. It produces larger, smoother, rounder fruits, of a good red color. John Baer and Chalk's Jewel are varieties that are identical with Bonny Best when good strains are obtained.

Livingston's Globe.—This variety classes as a second early. It has medium sized, round, pink or purple fruits, whch are firm and stand shipment well. It is used very extensively for shipping purposes throughout the southern states and in Mexico, but does not seem to be used much in California as yet.

Stone.—This is a late variety, having vigorous vines and large solid red fruits, which in good strains are smooth and nearly round. This variety has long been the standard for canning purposes in eastern regions, and is used for that purpose in California. It is also the sort generally grown now for the late shipping crop. Stone or Norton appear to be the most suitable varieties where it is desired to grow a "dual purpose" crop—that is, both for canning and for fall shipment.

Norton.—This is a selection from Stone developed especially for resistance to the Fusarium wilt, which is a valuable characteristic in many parts of the state where the soils are infected with the wilt disease. Otherwise, this variety is identical with the best-bred strains of Stone, and is suited to the same season and uses. Several competent observers are of the opinion that this variety will be of great value in California, as it was grown very successfully in several places in 1922.

San Jose Canner.—This variety is supposed to have come from Trophy, a very old variety. It has very large rank vines, and classes as very late in regard to maturity. Most of the common, or "growers strains" of this variety produce very large, rough, flattened, red fruits. It is a heavy yielder if plants are started early enough in the season. This variety is not suitable for shipment but is used most extensively for canning purposes in central and northern California. A few growers are said to have selected, improved strains.

Morse's San Jose Canner.—This is a recently introduced and much improved strain of the foregoing variety, having deep, smooth, meaty fruits, and should prove desirable for canning purposes.

SEED PRODUCTION

Comparatively few tomato growers are selecting and saving seed for their own use at the present time. Where one is engaged in

tomato production over a period of years, it is well worth while for the grower to select and save sufficient seed for his own use. Improved, acclimated strains, the result of careful selection, seem to be very scarce in California. Experiments elsewhere have shown that seed selected by farmers from their own fields out yield commercial seed from two to sixty per cent.

Most varieties usually contain plants varying a great deal in vigor and yield, as well as in quality and type of fruit. In fact, it seems that many seed stocks are actually mixed, containing many plants of poor type or low yield. The procedure recommended is to mark certain plants that show vigor, health and good type, about the time the fruits begin to ripen. The pickers are then instructed to take no fruit from the marked plants. A second inspection, two or three weeks later, will then enable one to judge of the productivity, quality and type of fruit. Those plants which seem desirable from this standpoint are selected, while the other plants marked at the first selection are discarded. It is best to save separately, and to plant one row in the field the next year with seed from each of the selected plants. The rest of the seed from the selected plants can be mixed and used for the main planting. From the best row the next year, seed is saved in sufficient quantity for the entire planting the third year. Practically all of the benefit derived from selection is apparent in the tomato the first year after the selection is made. Selection simply isolates the best qualities present in the original variety, and the improvement over the average is usually sufficient to make the practice quite profitable. However, selection should be continued from year to year to eliminate any degenerate plants and to preserve and improve, if possible, the qualities of the original selection. Indiscriminate selection of good fruits without reference to the vigor, health, yield and type of the plant from which the fruit came will not result in much improvement, for even poor plants may produce a few good fruits.

Generally speaking, the ideals in selecting tomatoes are: First, a vine that is large, vigorous, free from all disease, and producing a large yield of fruit; second, fruits that are medium to large, well colored, smooth, and deep, approaching the rounded form as closely as possible; thirdly, fruits which, when cut transversely, show well filled cells and freedom from greenish spots and hard white cores.

Fruits on plants from which seed are to be saved should be allowed to ripen fully on the vine. When large quantities are to be saved from a number of plants, the ripe fruit should be gathered at inter-

vals and dumped into wooden barrels, where it should be pounded into a pulp. No water should be added—there will be sufficient juice in the pulped fruits to insure speedy fermentation. After standing until the gelatinous mass surrounding the seed is well decomposed, water is added. Vigorous stirring facilitates separation of seed from pulp. The good seed sinks to the bottom while the light seed, skins, cores and pulp rise to the surface where they can easily be removed. Several successive washings clean the seed thoroughly, after which they should be removed, spread in thin layers on wire or cloth screens, and placed in the sun or elsewhere to dry as quickly as possible.

In cleaning seed on a larger scale, a flume with catch basins is used to separate seed from pulp, and the seed is dried in rotating cylinders through which a current of hot air is driven.

CONTROL OF TOMATO DISEASES

Damping-off. — This is a seed bed trouble which attacks tomatoes and all other plants grown in beds. It is due to several kinds of fungi which are often present in soils. (fig. 4). These fungi attack the plants at the surface of the soil, causing the stem to shrivel and turn black, while the top soon falls over. This disease is most likely to do serious damage when the same soil is used year after year for plant beds. It is also likely to spread rapidly when the surface of the soil is kept damp continually. The control consists in using fresh soil in the plant beds each year; watering plants only when absolutely necessary and then always in the forenoon so that plants and soil surface may dry off before night; ventilating the plant beds as freely as possible if they are covered; and avoiding over-crowding of plants by transplanting to proper distance or by thinning.

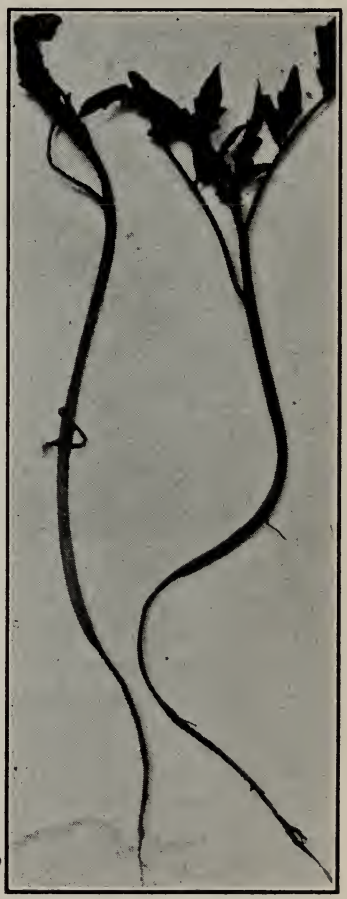

Fig. 4.—Damping off of tomato seedlings. This disease may be caused by several fungi which are particularly liable to become active when there is an excess of moisture.

Late-Blight.—This disease often appears in coastal districts on potatoes and tomatoes. It spreads only in moist cool weather. In southern California the late fall crop is sometimes very seriously injured by this disease when the fall rains come earlier than usual. Due to its irregular appearance, growers are seldom prepared to combat it, hence serious damage results occasionally. The effects of the disease appear soon after the rains commence in the form of numerous black spots on leaves and stems. The spots enlarge rapidly

Fig. 5.—Leaves of plant affected by "Western Blight," showing characteristic roll. This and the purple color of the veins are the early symptoms of the disease.

if the weather remains moist, and soon the whole plant blackens and dies. Fruits in all stages of maturity are affected, having small dark spots which enlarge rapidly and soon involve the decay of the whole fruit.

The control consists in spraying the plants thoroughly with Bordeaux mixture whenever early rains occur and the disease threatens. The spray material is prepared by dissolving separately, four pounds of Bluestone and four pounds of unslaked lime (or six pounds of hydrated lime). Each solution is diluted to 25 gallons and the two are then poured together, making 50 gallons of the spray material. Where no special spraying machines for use on tomatoes are available, power orchard sprayers can be used to spray the tomato fields.

Fusarium Wilt.—This disease is caused by a fungus living in the soil, which enters the plant through the roots. When the disease once gets into a field, it spreads rapidly in succeeding years. The disease is said to occur in many parts of the state. It usually appears a few weeks after the beginning of hot weather, the lower leaves of affected plants turn yellow and dry up (fig. 5). The stems, if split open reveal dark brown streaks in the woody portion. The disease advances rapidly and kills the entire plant, or sometimes only one of the main branches. There is no true wilting of the plant, in the ordinary sense of the word, connected with this disease. The control is to grow resistant varieties, of which the Norton seems best at present, though Marvel, an early variety, and Norduke, a late shipping sort, may be desirable under some conditions. These varieties were recently developed by the U. S. Department of Agriculture.

Summer Blight (*Western Blight*).—This trouble occurs very generally in the state and is known by several names. The cause is unknown. The disease usually appears about mid-summer and may gradually involve many plants during the season. Affected plants stop growing, the margins of the leaves roll upward, and the under sides become purplish. The leaves and tips of the stem gradually dry up, and eventually the whole plant dies. No satisfactory control measure can yet be recommended.

Root-Knot.—This trouble is caused by nematodes—microscopic worms which infest the soil and which enter the roots of tomatoes and many other plants, causing the characteristic swelling of the roots. Affected plants appear stunted and yellowed, and die slowly. The trouble can always be recognized by pulling up the plants and inspecting the roots. Extreme caution should be exercised by growers to prevent the introduction of the disease on vegetable plants or seed potatoes shipped from other sections. When once introduced into the soil, nematodes are very difficult to eradicate. Flooding the land for two or three months, thorough drying out of the soil over summer, summer fallow, and growing resistant crops for two years are practices that have been recommended. The small grains, the Iron variety of cowpea, and the velvet bean are some of the crops resistant to nematodes. One should always be sure that the soil used for plant beds is free from nematodes, for infected beds are often responsible for infecting a field and spreading the trouble.

Fruit Spot (*Anthracnose*).—This is caused by a fungus which attacks the fruit in damp weather in the fall. Sometimes the black circular spots of decay are noticeable when the fruit is picked, and

such fruit should of course be destroyed. The more serious damage caused by this disease, however, is the decay of fruit during shipment or after reaching market. There was some complaint of this the fall of 1922. It is believed that spraying the plants with standard Bordeaux mixture will control the disease, if applied just before the fruit begins to ripen. Spraying of course entails the additional task of wiping the fruit as it is packed. Infected fruit should be destroyed. Seed disinfection may aid in preventing the trouble.

Mosaic.—This disease causes a mottled appearance of the leaves; the plants are stunted and usually die without producing much fruit. The disease is readily spread in the field by insects and other means.

Fig. 6.—Tomatoes showing blossom end rot. The cause of this disease is somewhat obscure, but thus far remedial measures consist in giving good care and not allowing the plants to suffer for lack of water.

It has been recently reported as doing considerable damage in some places. Infected plants should be promptly pulled up and burned or buried. Probably the most important step in controlling the disease is to destroy the perennial weeds related to tomatoes, on which the disease over-winters. Horse-nettles, ground cherries and matrimony vine especially should be eliminted from the neighborhood of the plant beds and from the field as well, if possible. Tomatoes should not be grown after potatoes, for the volunteer potato plants which usually are quite numerous the year after potatoes are grown, would be a source of Mosaic infection to the tomato plants.

Blossom End Rot.—This is a common disease in most parts of the state, though the damage done varies much according to the season. The first stage occurs on either green or ripening fruits, as an irregular brownish patch at the blossom end of the fruit. If the trouble does not develop beyond this stage, as is sometimes the case, little harm is done. But generally the disease advances rapidly, develop-

ing a black dry leathery rot which may advance until the lower half of the fruit is decayed. The disease is usually associated with drought conditions, where the plants are not able, on account of dry soil or limited root system, to take up moisture as fast as it is needed. The disease also occurs where plants have made excessively rank growth of vines early in the season, and are then checked by insufficient moisture when the fruit is ripening. The prevention of this disease seems to lie in proper regulation of the moisture supply (fig. 6). Everything done to encourage development of a deep root system by the plant will also aid in preventing disease. Also, the selection of seed from plants bearing fruits not affected by the disease offers much hope for its control in succeeding years.

Failure to set fruit.—This is a frequent cause of trouble, especially at certain seasons of the year. Although the plants may bloom profusely many flowers may fall without setting fruit. One frequent cause of the trouble lies in the excessively rank vegetative growth of the plant, which is likely to occur when the water supply is too liberal or when the soil is excessively rich in nitrogenous matter. Another cause is the very low humidity of the air which often occurs in summer. This condition, in connection with high temperature and high winds, may cause most of the blossoms to fall.

Avoiding too much nitrogenous fertilizer and irrigating sparingly if at all during the first bloom stage, will promote a better set of fruits. Windbreaks and the selection of a type of plant having heavy foliage will be helpful in other cases.

For aid in preparing this circular, the writer is indebted to R. G. Risser of the California Vegetable Union; F. A. Dixon of the Canners League; S. W. Cunningham of the southern California Canners Bureau; and R. E. Smith, Plant Pathologist in the College of Agriculture.